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The Negative Impact of Preoperative Depression on Postoperative Functional Outcomes of Total Knee Arthroplasty

Abstract

Background: Over 600 000 total knee arthroplasties (TKA) are performed per year in the United States, and about 20% of patients report poor and/or unsatisfactory outcomes following TKA. Additionally, about 22.5% of patients undergoing TKA meet clinical criteria for major depressive disorder. Previous research has revealed an association between preoperative depression and increased postoperative pain post-TKA. This review seeks to determine the relationship between preoperative depression and functional outcomes post-TKA.

Methods: An exhaustive search of available medical literature was conducted using MEDLINE, CINAHL, and Web of Science. Keywords used included: “depression,” “preoperative depression,” “arthroplasty, replacement, knee,” and “total knee arthroplasty.” Included studies were assessed for quality using GRADE criteria.

Results: Eighty-two studies were reviewed for relevancy, and three prospective cohort studies met inclusion criteria. Two studies revealed negative correlations between preoperative depression and poorer functional outcomes as measured by the Western Ontario and McMasters Osteoarthritis Index (WOMAC). The third study showed a significant independent relationship between preoperative depression as measured by the Hospital Anxiety and Depression Scale (HADS) and poorer performance on the Knee injury and Osteoarthritis Outcome Score (KOOS) ADL subscale.

Conclusion: Across the three studies included in this systematic review, preoperative depressive symptoms are negatively associated with functional outcomes after TKA. Further research is necessary to determine the best treatment approach for TKA candidates with comorbid depression, especially if treating preoperative depression could potentially improve postoperative functional outcomes.

Keywords: Depression, preoperative depression, and total knee arthroplasty

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The Negative Impact of Preoperative Depression on Postoperative Functional Outcomes of Total Knee Arthroplasty

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*A Clinical Graduate Project Submitted to the Faculty of the
School of Physician Assistant Studies*

Pacific University

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Faculty Advisor: Mark Pedemonte, M.D.

Clinical Graduate Project Coordinator: Annjanette Sommers, PA-C, MS

Biography

Elizabeth Hughes is a native of Westford, Massachusetts. She received her Bachelor of Arts degree in 2013 from Colby College in Waterville, Maine with a double major in Biology (Neuroscience Concentration) and Mathematical Sciences, and a minor in Italian Studies. Prior to PA school she worked as an EMT and as a medical care provider for children at a summer camp. In her spare time she enjoys running, hiking, reading, and fantasizing over her future dog. After PA school, she plans to solidify her skills by working in primary care.

Abstract

Background: Over 600 000 total knee arthroplasties (TKA) are performed per year in the United States, and about 20% of patients report poor and/or unsatisfactory outcomes following TKA. Additionally, about 22.5% of patients undergoing TKA meet clinical criteria for major depressive disorder. Previous research has revealed an association between preoperative depression and increased postoperative pain post-TKA. This review seeks to determine the relationship between preoperative depression and functional outcomes post-TKA.

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Conclusion: Across the three studies included in this systematic review, preoperative depressive symptoms are negatively associated with functional outcomes after TKA. Further research is necessary to determine the best treatment approach for TKA candidates with comorbid depression, especially if treating preoperative depression could potentially improve postoperative functional outcomes.

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List of Abbreviations

TKA.....	Total Knee
Arthroplasty	
THA.....	Total Hip Arthroplasty
HADS.....	Hospital Anxiety and Depression Scale
KOOS.....	Knee injury and Osteoarthritis Outcome Score
HOOS.....	Hip disability and Osteoarthritis Outcome Score
ADL.....	Activities of Daily Living
BDI.....	Beck's Depression Inventory
WOMAC.....	Western Ontario and McMasters Universities Osteoarthritis Index
KSS.....	Knee Society Clinical Rating System
DASS21.....	Depression, Anxiety, and Stress Scale 21
OA.....	Osteoarthritis

The Negative Impact of Preoperative Depression on Postoperative Functional Outcomes of Total Knee Arthroplasty

BACKGROUND

According to the American Academy of Orthopedic Surgeons, over 600 000 total knee arthroplasty (TKA) surgeries per year are performed in the United States alone.¹ TKA is considered an effective intervention in reducing pain and improving function in end stage osteoarthritis patients. About 20% of patients, however, are unsatisfied with their outcome after TKA.² Due to this high rate of dissatisfaction, researchers began to attempt identification of risk factors for poorer outcomes of TKA. In a 2007 study, Wylde et al³ determined that dissatisfaction post TKA cannot be explained completely by differences in physical characteristics of the patients, differences in the surgical procedures used, or physical comorbidities of the patients. After ruling out these potential factors, research turned to retrospective analysis of patients who experienced poor outcomes and determining commonalities amongst them. Consequently in 2012, Judge et al⁴ discovered that age, gender, severity level of preoperative disease, poorer socioeconomic status, and anxiety/depression were clinically relevant predictors of TKA outcome. Of these risk factors, the only modifiable one is the presence of psychological symptoms, which makes it of particular interest.

Further research revealed that 22.5% of patients scheduled to undergo TKA met criteria for major depressive disorder.⁵ Preoperative depression has been shown previously to be associated with increased pain postoperatively.⁶⁻⁹ The question of the impact of preoperative depression on functional outcomes, however, has yet to be conclusively answered.

Two systematic reviews on the topic of preoperative depression and functional outcomes of TKA have yielded inconclusive results. Vissers et al¹⁰ conducted a systematic review on the psychological factors that affect the outcomes of total hip arthroplasty (THA) and TKA. Thirty-five studies were included in the review, but only two of the included studies directly addressed the effect of depression on functional outcomes after TKA. Vissers et al¹⁰ concluded that there is limited evidence on the effect of depression on functional outcomes with less than one year of postsurgical follow-up, and conflicting evidence on the effect of depression on functional outcomes with more than one year of postsurgical follow-up. However, one of the included studies lacked a validated score for measuring postoperative knee function; therefore, the strength of the evidence supporting the conclusion of Vissers et al¹⁰ is low.

Paulsen et al¹¹ performed the second systematic review on this topic. Eight studies were summarized in this review, and it was concluded that four studies showed a relationship between preoperative psychological distress and poor functional outcomes, while the other four included studies revealed no relationship. The high level of heterogeneity amongst the included studies likely contributed to this inconclusive result. These eight studies lacked disease specific questionnaires to assess for psychological distress and lacked functional outcome scoring systems specific to the knee.

This review, therefore, seeks to elucidate the relationship between preoperative depression and postoperative functional outcomes, as the previous research is inadequate. Prior research focuses little on depression alone as an independent psychological factor that could impact functional outcomes. If in fact there is a connection between poorer functional outcomes and preoperative depression, it would be beneficial to screen for depression in preoperative

patients and to potentially treat them preoperatively, in order to obtain improved surgical outcomes.

METHODS

An exhaustive search of the literature was performed using MEDLINE, CINAHL, and Web of Science. The keywords “depression,” “preoperative depression,” “arthroplasty, replacement, knee,” and “total knee arthroplasty” were used. Articles that addressed the effect of preoperative depression on postoperative functional outcomes post-TKA were considered. For inclusion, studies were required to use a measure specific for depression and a measure specific for knee function. Studies were additionally required to be written and published in English. Studies were excluded if they were published before December 2010, as this was the end-date for inclusion criteria of the Vissers et al study,¹⁰ which was the last systematic review to broadly cover this topic. Article selection was made by screening the title and abstract. The search was expanded by reviewing the bibliographies of included studies. Relevant studies were assessed for quality using the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) criteria.¹²

RESULTS

The search strategy, as outlined above, yielded 82 potential articles for review. After screening the title and abstract, five studies remained. The full text of five articles was reviewed for primary data with specific measures of both depression and knee function. After this review two prospective cohort studies remained.¹³⁻¹⁴ One additional prospective cohort study¹⁵ was added after review of the references of the included studies. See Tables 1 and 2.

Lopez-Olivo et al

This prospective cohort study¹⁵ aimed to identify potential associations between psychosocial factors and clinical success following TKA. All patients scheduled for TKA between May 2004 and October 2005 at St. Luke's Episcopal Hospital in Houston, Texas from two outpatient clinics in the area were eligible for the study. Further inclusion criteria for participation were: radiographic diagnosis of knee osteoarthritis, primary TKA, adequate cognitive status, living in the community (not in a long-term care facility), and ability to communicate in English. Exclusion criteria consisted of: revision surgery, inflammatory arthropathies, neurological disorders, Paget's or other bone disorders, litigation process related to surgery, and patients seeking workers' compensation benefits.¹⁵

The study recruited 272 patients on a volunteer basis to participate. Of those, 241 patients (89%) underwent TKA and completed full follow-up. Patients were assessed preoperatively and at 6 months postoperatively with the Knee Society Clinical Rating System (KSS); the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC); Medical Outcome Study-Social Support Scale (MOS-SSS); Depression, Anxiety, and Stress Scale 21 (DASS21); Coping Responses Inventory (COPE); Arthritis Self-efficacy Scale (ASES), and the Life Orientation Test-Revised (LOT-R). Of interest to this systematic review are the clinical outcomes as measured by the KSS and WOMAC scales, and psychological status as measured by the DASS21. The KSS has two subscores, one that measures the knee joint itself (KSS A) and one that measures knee function via the ability to walk and climb stairs (KSS B). Each subscore ranges from 0 to 100 where lower scores indicate poorer knee function. Patients were also assessed with the WOMAC scale, which includes subscales for pain, function, and stiffness. Each subscore ranges from 0 to 100, where higher scores indicate poorer knee function. Finally,

psychological status was measured with the DASS21, which is a validated tool with three subscales: one for depression, one for anxiety, and one for stressors. There are 7 items on each subscale. Scores range from 0 to 42 with higher scores indicating more severe psychological state. Potential confounders, which included BMI, comorbidities, and baseline WOMAC/KSS score, were controlled for in the statistical analysis.¹⁵

Overall, this study concluded that DASS21 depression subscore was significantly correlated with WOMAC pain subscore, WOMAC function subscore, KSS total score, and KSS function subscore, with Spearman correlations of 0.20, 0.25, -0.26, and -0.30 respectively (p-value less than 0.05 for all correlations). Furthermore, after stepwise multiple linear regression analysis, it was shown that worsening WOMAC function scores were independently associated with DASS21 depression scores, such that higher DASS21 scores (worsening depression) were associated with higher WOMAC function scores (poorer functional outcomes). The beta coefficient for this relationship was 0.15, which was significant with a p-value of 0.02. This study also concluded that poorer functional outcome as measured by KSS function subscores was negatively associated with worsening depression (beta coefficient of -0.19, with p-value of 0.0006). Finally, this study determined that of all the variability in functional outcomes, about 7-14% of the variance can be explained by psychological factors alone, including depression, anxiety, stress responses, coping responses, and self-efficacy.¹⁵

Limitations of this study include possible volunteer bias as participation was on a volunteer basis. This study's generalizability is also limited due to the inclusion of only one hospital in the eligibility criteria. Finally, adherence to rehabilitation programs was not tracked; therefore, it is possible that poorer functional outcomes were due to inadequate or incomplete rehabilitation.¹⁵

Hirschmann et al

This prospective, longitudinal, single-cohort study¹³ examined the relationship between preoperative psychological factors and both objective and subjective outcomes after TKA. Inclusion criteria for the study included: primary osteoarthritis of the knee, age over 50 years old, no previous diagnosis or treatment of depression or other psychological disorders, adequate cognitive function to fill out assessment forms, and availability for clinical and radiographic follow-up. Included in this study were 110 consecutive patients, and 104 patients had full clinical and radiological follow-up. All included patients underwent TKA with a standardized surgical procedure and received the same level of postoperative care and rehabilitation. Patients' psychological state was measured preoperatively with the Beck's Depression Inventory (BDI), the State Trait Anxiety Index (STAI), Symptom Checklist 90-Revised (SCL-90R), and a questionnaire that assessed for self-efficacy of the patients.¹³

Of interest to this systematic review is the preoperative measurement of depression as measured by the BDI, which is a 21-item questionnaire that assesses for the severity of depression, and as measured by the SCL-90R depression subscale. Both a higher BDI score and a higher SCL-90R score indicate more severe depression. Patients' clinical outcomes were assessed preoperatively, and at 6 weeks, 4 months, and 12 months postoperatively with a visual analog scale for knee pain, the KSS scale, and the WOMAC index. As this systematic review is only examining knee function, the KSS B and the WOMAC function subscores will be of interest, both of which were previously discussed.¹³

Over the one year follow-up period, the cohort as a whole improved with respect to their knee function, such that WOMAC scores significantly decreased over one year and KSS scores significantly increased over one year. This result continues to prove that TKA is an effective

therapeutic intervention for improving osteoarthritis related pain and functional limitations. At one year post-TKA, depression as measured by the BDI and as measured by the SCL-90R depression subscore was significantly correlated with WOMAC function subscore with correlations of 0.37 and 0.41 respectively (p-value less than 0.001 for both correlations). Depression as measured by BDI and as measured by SCL-90R depression subscore was not significantly correlated with KSS B subscore; however, KSS is an unvalidated tool for measuring knee function outcomes, which undermines the support for this result. Therefore, the overall findings of the study indicate that higher levels of preoperative clinical depression predict poorer functional outcomes post-surgically.¹³

This study had few limitations. All of the patients were selected from a single center; therefore, the population has limited generalizability. Additionally, confirmation of TKA placement was performed radiographically, while 3D-CT is the gold standard. Thus it cannot be excluded that some functional limitations were due to poor TKA placement.¹³

Duivenvoorden et al

This prospective cohort study¹⁴ sought to determine if psychological factors (anxiety and depression) contribute to poorer outcomes after TKA and total hip arthroplasty (THA). To be eligible for the study, patients were required to be on the waiting list for primary TKA or THA between March 2009 and August 2010 at three separate hospitals in the Netherlands. Participants were measured preoperatively, and at 3 and 12 months postoperatively using the Hospital Anxiety and Depression Scale (HADS), a satisfaction questionnaire, and either the Knee injury and Osteoarthritis Outcome Score (KOOS) or the Hip disability and Osteoarthritis Outcome Score (HOOS). The HADS is a validated tool with two subscales, one for anxiety and one for depression. The subscale scores range from 0 to 21 where higher scores indicate more severe

distress. This study used a subscale score greater than or equal to 8 to indicate the presence of anxiety or depression, which yields a sensitivity and specificity of 0.80 for either psychological outcome. The general satisfaction questionnaire contained questions regarding patient characteristics, use of pain medications, use of antidepressants, concurrent psychological treatment, and patient satisfaction. Finally, patients were given either the KOOS or HOOS questionnaire to measure post-surgical outcomes. The HOOS and KOOS each include five metrics: pain, symptoms, functioning in activities of daily living (ADL), functioning in sports and recreation, and hip or knee related quality of life. Each subscale is normalized from 0 to 100, where 0 indicates severe symptoms and 100 indicates no symptoms.¹⁴

Overall, 243 THA and 208 TKA patients were eligible for the study. Full postoperative data was obtained from 149 THA and 133 TKA patients. The study was adjusted for potential confounders and for losses to follow-up. Though this study measured both anxiety and depression and included patients undergoing both THA and TKA, only the results of the depression subscale of the HADS in those patients undergoing TKA will be considered in this systematic review. Additionally, only the function subscales of the KOOS will be considered.¹⁴

This study concluded that more depressive symptoms, as measured by the HADS depression subscale, predicted a smaller change in KOOS pain, ADL and quality of life subscales, and that this relationship is independent of age, gender, and preoperative KOOS score of the patient. Specifically, KOOS ADL subscale at 12 months post-TKA showed 81.8 +/- 17.0 for non-depressed and 70.6 +/-20.7 for depressed participants. The beta coefficient was significant for an independent relationship between depressive symptoms and change in ADL subscore ($\beta = -9.7$ with a 95% confidence interval of -16.8 to -2.6). This indicates that as the HADS score increases (worsening depressive symptoms), the KOOS ADL subscore decreases

(poorer functional outcome). The beta coefficient for the relationship between the KOOS Sport subscale and the HADS score, however, was not significant ($\beta = -3.5$ with a 95% confidence interval of -16.1 to 9.1), which indicates that depressive symptoms do not predict a poorer functional outcome as measured by the KOOS Sport subscale.¹⁴

There are five major limitations to this study as identified by the authors. The first is that there was over 30% loss to follow-up, which caused gender to become an unbalanced characteristic when comparing the original cohort to the final cohort from which data was obtained. The authors compensated for this by adjusting for gender as a confounder; however, selection bias could still be present. The second limitation is that there was no calculation of the number of participants needed prior to the study. A post-hoc power analysis revealed that the study overall had 0.80-0.98 power for the study outcomes. Thirdly, the timing of the preoperative assessment point was not standardized; it is therefore possible that depressive symptoms could change over the preoperative period as this was not controlled. The study also did not obtain consent from participants to obtain their medical records which caused the authors to be unable to adjust for medical comorbidities. Finally, the HADS questionnaire measured anxiety and depression symptoms, which is not a substitute for diagnosing depression. It is likely that the HADS overestimated the prevalence of anxiety and/or depression in the study population.¹⁴

DISCUSSION

It is well-established that preoperative depression is associated with increased levels of postoperative pain, but it was previously undetermined if preoperative depression is associated with poorer functional outcomes post-TKA. Previous systematic reviews¹⁰⁻¹¹ yielded inconsistent and inconclusive results due to the lack of validated outcome measures, and lack of a specific

focus on one psychological factor. This systematic review used a narrowed scope and examined the effect of only one psychological variable (depression), on functional outcomes, and included only studies that used validated tools to measure the outcomes of interest, such as the WOMAC index, and the KOOS.

Across the three studies¹³⁻¹⁵ included in this review, preoperative depressive symptoms are negatively associated with functional outcomes after TKA. Lopez-Olivo et al¹⁵ concluded that depression as measured by DASS21 is significantly correlated with WOMAC and KSS function subscores, such that worsening depression predicts poorer function postoperatively. Likewise, Hirschmann et al¹³ concluded that depression as measured by the BDI and as measured by the SCL-90R depression subscore are significantly correlated with WOMAC function subscores, such that increasing depressive symptoms are associated with worsening WOMAC outcomes. Finally, Duivenvoorden et al¹⁴ concluded that preoperative depression is a significant predictor of poorer postoperative functional outcomes as measured by the KOOS ADL subscore. This represents a dose-response gradient such that patients with worsening depression have poorer functional outcomes. From these three studies, there is a clear negative impact of depression on functional outcomes after knee replacement.

The major limitation of this systematic review is that all included studies were prospective cohort in design; therefore, no causal relationship between preoperative depression and TKA functional outcomes can be determined. As all of the included studies were observational in nature, this lowered the quality of evidence of the study findings (Table 1). This review is also limited due to the heterogeneity of questionnaires that were used in each individual study. All three included studies¹³⁻¹⁵ used different measures of depression, and only two of the three included studies¹⁴⁻¹⁵ used the same measure of functional outcome. There is

therefore no ability to pool the data and create a conglomerate conclusion. This review is also limited by the individual limitations of each of the included studies. Specifically, one study conducted by Duivenvoorden et al¹⁴ was severely limited due to concerns of precision and methodology. Precision was a concern because of the large loss to follow-up (over 30%) and the lack of a power analysis prior to enrolling participants. Methodology was also a concern as the researchers did not standardize the timing of the preoperative assessment and did not control for possible medical comorbidities. Finally, all of the included studies used questionnaires to assess for the presence of preoperative depression. These questionnaires are limited by the subjectivity of patients assessing their own mood.

Despite the limitations posed by reviewing observational studies, there is convincing evidence of the negative impact that preoperative depression has on postoperative functional outcomes post-TKA. Previous research, however, has shown that depressed patients still show improvement post-TKA, and some research has even shown that patients' depressive symptoms improve after TKA.² Future research therefore should focus on determining treatment guidelines for TKA candidates with comorbid depression, i.e. should patients with preoperative depression be treated for depression prior to TKA surgery in order to improve their functional outcomes. This would be determined best with a randomized controlled trial that compares functional outcomes of patients with diagnosed depression who are treated preoperatively versus patients with diagnosed depression who are not treated preoperatively. Additionally, further investigation seems warranted to determine if depression impacts surgical outcomes broadly, outside of TKA and orthopedic surgeries. If treating depression preoperatively could improve outcomes across all types of surgery, this could reduce hospital stays, decrease reliance on rehabilitation, improve patient satisfaction, and decrease healthcare costs.

CONCLUSION

Overall, there is conclusive evidence across the three studies summarized in this review that preoperative depression negatively impacts postoperative functional outcomes of TKA. In the primary care setting, depression is a modifiable condition that afflicts about 22.5% of patients with osteoarthritis who are awaiting a TKA. Furthermore, TKA is one of the most commonly performed surgeries with 600 000 surgeries performed per year in the United States alone. Since preoperative depression is significantly associated with poorer outcomes, primary care clinicians and orthopedic clinics should screen for and potentially treat depression preoperatively in order to improve post-surgical outcomes. Further research will determine if there is, in fact, a significant benefit in treating depression preoperatively in order to improve functional outcomes of TKA and other surgeries. Until more research is conducted, providers should understand the negative correlation between preoperative depression and functional outcomes post-TKA. Providers should also consider treatment of preoperative depression in order to potentially improve postoperative functional outcomes of knee replacement surgery.

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Table 1. GRADE evidence profile for the impact of depression on the functional outcomes of TKA.

Quality Assessment									
Study	Design	Downgrade Criteria					Upgrade Criteria		Quality
		Limitations	Indirectness	Imprecision	Inconsistency	Publication bias likely	Large treatment effect	Dose-Response gradient	
<i>Lopez-Olivo et al¹⁵</i>	Prospective cohort	No serious limitations	No serious indirectness	No serious imprecision	No serious inconsistencies	No bias likely	No	Yes ^a	Moderate
<i>Hirschmann et al¹³</i>	Prospective cohort	No serious limitations	No serious indirectness	No serious imprecision	No serious inconsistencies	No bias likely	No	No	Low
<i>Duivenvoorden et al¹⁴</i>	Prospective cohort	Serious limitations ^b	Serious indirectness ^c	Serious imprecision ^d	No serious inconsistencies	No bias likely	No	No	Very Low

^aRegression analysis showed that worsening WOMAC function scores were independently associated with DASS21 depression scores such that a dose-response effect exists between worsening depression and poorer functional outcomes.

^bLack of consistent timing for preoperative depression assessment and lack of controlling for potential medical comorbidities.

^cUse of HADS, which is not diagnostic of depression, likely overestimated the prevalence of depressive symptoms.

^dLarge loss to follow-up and underpowered study.

Table 2. Summary of study characteristics and key findings from each study.

Study	Design	Number of Patients	Measure of Depression	Measure of Knee Function	Time to Follow-up	Key Findings
<i>Lopez-Olivo et al¹⁵</i>	Prospective cohort	241	DASS21	WOMAC KSS	6 months post-op	Depression is negatively associated with WOMAC function and KSS function subscores at 6 months post-op (correlations of 0.25 and -0.30 respectively) ($p < 0.001$).
<i>Hirschmann et al¹³</i>	Prospective cohort	104	BDI, SCL-90R Depression subscore	WOMAC KSS	6 weeks, 4 months, 12 months post-op	One year post TKA, depression, as measured by both BDI and SCL-90R subscore, was significantly correlated with WOMAC function subscore (correlations of 0.37 and 0.41 respectively) ($p < 0.0001$).
<i>Duivenvoorden et al¹⁴</i>	Prospective cohort	133	HADS	KOOS	3 months, 12 months post-op	Depression is an independent predictor of less improvement on KOOS ADL subscore postoperatively.

